Chapter 19
Evidence-Centered Concept Map in Computer-Based Assessment of Critical Thinking

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ABSTRACT

A concept map is a graphical tool for representing knowledge structure in the form of a graph whose nodes represent concepts, while arcs between nodes correspond to interrelations between them. Using a concept map engages students in a variety of critical and complex thinking, such as evaluating, analyzing, and decision making. Although the potential use of concept maps to assess students' knowledge has been recognized, concept maps are traditionally used as instructional tools. The chapter introduces a technology-enabled three-phase Evidence-Centered Concept Map (ECCM) designed to make students' thinking visible in critical thinking assessment tasks that require students to analyze claims and supporting evidence on a topic and to draw conclusions. Directions for future research are discussed in terms of their implications to technology tools in large-scale assessment programs that target higher-order thinking skills.

INTRODUCTION

In today's global economy, the need for higher levels of education and thinking skills is large and growing. Proficiency in critical thinking is key not only to unlocking the world of higher education but also in the workplace and in personal, social, and civic life. In light of the importance of critical thinking skills, current large-scale assessment programs such as the Program for International Student Assessment (PISA) and the U.S. National Assessment of Educational Progress (NAEP) have embedded critical thinking in K12 assessment of science, math, and reading, as has the OECD Programme for the International Assessment of Adult Competencies (PIAAC). According to the Partnership for 21st Century Skills (2009) and Assessment and Teaching of 21st Century Skills

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(Binkley et al., 2012), a set of critical thinking competencies includes skills such as analyzing how parts of a whole interact with each other, synthesizing and making connections between information and arguments, and asking meaningful questions to clarify various points of view. Critical thinking requires the competencies of evaluating the credibility of sources, analyzing the quality of arguments, making inferences using reasoning, and decision-making (see Lai, & Viering, 2012, for a literature review). Measuring complex skills such as critical thinking and other higher-order skills requires designing and developing assessments that address the multiple facets implied by the skill. One of the possible ways to achieve these changes in educational assessment is by providing visible sequences of actions that students have taken by using technology tools. Thinking tools are computer applications that enable students to represent what they have learned and know using different representational formalisms. Studying the role of thinking tools (often called graphic organizers) in computer-based formative assessment of higher-order thinking skills is crucial to determining whether these types of scaffolding tools can bring a real added value into large-scale programs. An interactive Evidence-Centered Concept Map (ECCM) is one of the promising technology tools in making student thinking visible in critical thinking formative assessments (Rosen, 2014; Rosen, & Tager, 2014). When creating an ECCM, students perform a task that no ordinary collection of notes may encompass. ECCM represents a personal visualization of claims and supporting evidence on a topic, as well as relationships between the claims. The tool also represents possible gaps in a student's analysis of the topic and the ability to make a valid and reliable evidence-based conclusion. In this way, concept maps along with feedback system can be used as a formative assessment tool to enhance teaching and learning. This chapter provides a comprehensive overview of ECCM, illustrates a sample task in ECCM-based critical thinking formative assessment along with the major findings from an international pilot study, and discusses implications for development and further research directions.

BACKGROUND

People make decisions on very limited evidence and often assert their proposition with great confidence. They tend to believe their current information set is complete and reliable. Kahneman (2011) calls this pattern What You See is All There Is (WYSIATI). Another consequence of WYSIATI is that people evaluate complex topics without considering a wider range of alternatives or trying to get more information that could potentially contradict the decision. The individual may understand in principle that worthless information should not be treated differently from a complete lack of information, but WYSIATI limits the ability to apply this principle. A student that follows WASIATI will achieve high confidence much easier by ignoring what is unknown. Thus, teachers should provide students with practice in a basic understanding of the nature of evidence and well-formed arguments. Analyzing errors addresses the logic, reasonableness, or accuracy of claims; making and defending claims are at the heart of critical thinking instruction and assessment. According to Marzano (2007), students should be taught to identify validity of claims by analyzing their grounds, backing, and qualifiers. The students do not have to understand the technical aspects of grounds, backing, and qualifiers, such as their names and defining characteristics. However, students should be aware that to be valid, claims should be supported by initial evidence (grounds), the sources of the supporting evidence should be identified (warrants), the evidence should be explained and discussed (backing), and exceptions to the claims should be identified (qualifiers). Thus, providing students with opportunities to evaluate the completeness of information across